MIST INTERVAL AND K-IBA CONCENTRATION INFLUENCE ROOTING OF

ORANGE AND MOUNTAIN AZALEA

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ABSTRACT

Using a Mississippi source of orange (*Rhododendron austrinum* (Small) Rehd. [Ericaceae]) and mountain (*Rhododendron canescens* (Michx.) Sweet) azalea, we found that treating terminal softwood cuttings with 10 000 ppm K-IBA yielded the best rooting performance in terms of root number, length, and quality when misted 4 s every 6 min (4 s:6 min). Rooting percentage of orange and mountain azalea was similar from 0 to 10 000 ppm K-IBA. For orange azalea, cuttings treated with 7500 ppm K-IBA had more roots compared with plants treated with 0 ppm K-IBA. Cuttings treated with 7500 or 10 000 ppm K-IBA had greater average root length and higher root quality compared with the control. Cuttings placed under mist for 4 s:6 min had more roots compared with cuttings placed under mist for 4 s:12 min. For mountain azalea, cuttings treated with 10 000 K-IBA had more roots, greater average root length, and higher root quality compared with cuttings treated with 0 ppm K-IBA. Cutting growth was greater under 4 s:6 min than 4 s:12 min. Although information on vegetative propagation of native azaleas is limited, and other cultural practices may affect misting interval and K-IBA concentrations, these results should help growers produce more plants for market until additional discoveries are made.

KEY WORDS

Rhododendron austrinum, Rhododendron canescens, Ericaceae, native plant, cutting propagation, auxin, [potassium salt] indole-3-butyric acid, IBA, K-IBA

NOMENCLATURE

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Orange azalea (*Rhododendron austrinum* (Small) Rehd. [Ericaceae])
Photo by Patricia R Knight

Several native azaleas of the southeastern US flower in the early spring when few other plants are blooming, adding much needed color to the landscape. Because of their bloom time and delicate beauty, native azaleas are undoubtedly one of the most spectacular flowering deciduous shrubs. Two of the earliest spring-flowering native azaleas (Ericaceae) are *Rhododendron austrinum* (Small) Rehd. and *R. canescens* (Michx.) Sweet (Galle 1987).

Rhododendron austrinum, orange azalea, is a medium to tall branched shrub that can reach heights of 4.6 m (15 ft) (Galle 1987). Flower color ranges from pure yellow to yellowish-orange. Flowers, 2.5 to 3.8 cm (1 to 1.5 in) long, appear prior to the leaves in clusters of 8 to 15 blooms. Native range of orange azalea is northern Florida, coastal Alabama, southern Georgia, and southeastern Mississippi. Orange azalea is hardy in USDA hardiness zones 6b–10a.

Rhododendron canescens, mountain azalea, is a medium to tall shrub that may exceed 4.6 m (15 ft) tall and may sometimes be stoloniferous (Galle 1987). Flower color ranges from white to medium or dark pink with white to dark pink corolla tubes, rarely with a blotch. Flowers appear prior to, or as, the leaves emerge and are 2.5 to 3.8 cm (1 to 1.5 in) in size. Native range of mountain azalea is the coastal plains of North Carolina to Florida and west to Oklahoma and southeastern Texas. Mountain azalea can also be found in the mountain areas of North Carolina, Georgia, Alabama, Mississippi, Tennessee, and Arkansas. Mountain azalea is hardy in USDA hardiness zones 6a–10a.

Reports vary concerning the ease of propagating native azaleas. Bir (1992) reports that native azalea cuttings root best from terminal softwood cuttings taken when new growth has ceased. A 0.5% to 0.8% indole-3-butyric acid (IBA) powder or 1000–2500 ppm IBA solution is recommended. Cuttings can be forced to root under lights or can be left undisturbed through normal winter chilling until new growth starts in the spring. Galle (1987) reports that orange azalea is easy to propagate from softwood cuttings while mountain azalea is moderate to easy to propagate from softwood cuttings. Berry (1998) reports that orange and mountain azalea can be propagated from soft new growth using 5000 ppm of the potassium salt of IBA (K-IBA). Optimum months are mid-May through mid-June. Knight and others (2001) reported the best rooting response for mountain azalea occurred between 8000 and 10 000 ppm K-IBA. Utilization of a 10 000 ppm K-IBA quick dip resulted in 100% rooting.

Sommerville (1998) anecdotally reports success propagating native azaleas in full sunlight using softwood cuttings, 0.8% IBA, and misting either 2 s:2 min or 1 s:1 min from 8:00 until 19:00. Dirr and Heuser (1987) reported that stoloniferous native azaleas often root easier than non-stoloniferous species. Major problems associated with native azalea propagation are rooting the cuttings and inducing new growth in spring. Dirr and Heuser (1987) suggest taking 15-cm (6-in) cuttings when tissue is slightly firm, removing all but 4 leaves, and wounding. They recommend using 4000 ppm IBA with a fungicide and sticking cuttings in a 100% peat moss medium.

Because information concerning optimum hormone concentration is varied and information concerning optimum moisture requirements is limited for cutting propagation, the objective of this experiment was to determine the optimum K-IBA concentration and mist interval for propagation of orange and mountain azalea.

MATERIALS AND METHODS

Terminal softwood cuttings of *Rhododendron austrinum* and *R. canescens*, each 15 cm (6 in) long, were taken on 11 April 2003 from established plantings at Crosby Arboretum, Picayune, Mississippi (USDA zone 8b). Cuttings were stored at 100% relative humidity during transport to Poplarville, Mississippi, and were stuck the same day. Two to four terminal leaves were left on each cutting, and the basal end was wounded to a length of 2.5 cm (1 in) by using a knife to remove the bark and cambial layer on one side of the cutting. Cuttings were quick-dipped for 5 s in the respective K-IBA solutions and immediately stuck in 7-cm (3-in) pots to a depth of 2.5 cm (1 in). Propagation medium was 100% pine bark amended with 2.9 kg/m^3 (5 lb/yd^3) dolomitic limestone and 0.9 kg/m^3 (1.5 lb/yd^3) Micromax (The Scotts Company Inc, Maryville, Ohio). Cuttings received mist from 7:00 until 17:30 daily. Average photosynthetically active radiation levels ranged from 800 to 1000 µmol/m/sec.

K-IBA concentrations utilized in this experiment were 0, 2500, 5000, 7500, or 10 000 ppm. Misting intervals were 4 s:6 min or 4 s:12 min. Data collected for this experiment included rooting percentage, cutting growth (cm of new growth on each cutting), cutting quality (0–5, with 0 being dead and 5 being a healthy, well-rooted cutting), root number, average root length (length in cm of 3 longest roots/3), and root quality (0–4, with 0 being dead and 4 being excellent). Data were collected on 7 July 2003.

Experimental design was a simple split-plot with 6 replications consisting of 2 plants per experimental unit. Mist interval (4s:6 min or 4s:12 min) was the main plot, and K-IBA concentration (0, 2500, 5000, 7500, or 10 000 ppm) was the subplot. Significance of main plots of mist interval and split-plots of K-IBA concentration was determined using the general linear models procedure of SAS (SAS Institute Inc 1989). K-IBA concentration means were separated at the 5% level using Dunnett's two-tailed *t* test. Mist interval means were separated at the 5% level using Fisher's Protected Least Significant Difference. Data for all response variables were regressed on hormone concentration using the regression procedure of SAS (SAS Institute Inc 1989). Each species was analyzed as a separate experiment.

RESULTS

Orange Azalea

Rooting percentage ranged from 63% for cuttings dipped in 0 or 2500 ppm K-IBA to 100% for cuttings dipped in 10 000 ppm K-IBA (Table 1). Cuttings treated with 5000 or 7500 ppm K-IBA had 50% or 38% rooting, respectively. Rooting percentage ranged from 75% for cuttings placed in mist for 4s:6 min to 60% for cuttings placed in mist for 4s:12 min. No significant differences in rooting percentage due to K-IBA concentration or mist interval were observed.

Cuttings treated with 7500 ppm K-IBA had more roots compared with cuttings treated with 0 ppm K-IBA (Table 2). Root numbers of cuttings treated with 2500, 5000, or 10 000 ppm K-IBA did not differ from root numbers of cuttings treated with 0 ppm K-IBA. Average root length and root quality of cuttings treated with 7500 or 10 000 ppm K-IBA were greater than average root lengths and root quality ratings of cuttings treated with 0 ppm K-IBA. Average root length and root quality of cuttings treated with 2500 or 5000 ppm K-IBA, however, were similar to ratings for cuttings treated with 0 ppm K-IBA. Cutting growth was unaffected by K-IBA concentration. Mist interval did not influence average root length, root quality, or cutting growth (Table 2). Root number was greater for cuttings placed in mist for 4s:6 min compared with cuttings placed in mist for 4s:12 min.

Mountain Azalea

Rooting percentage ranged from 75.0% for cuttings treated with 0, 2500, or 5000 ppm K-IBA, 87.5% for cuttings treated with 10 000 ppm K-IBA, and 100% for cuttings treated with 7500 ppm K-IBA (Table 1). Rooting percentage ranged from 95% for cuttings placed in mist for 4 s:6 min compared with 70% for cuttings placed in mist for 4 s:12 min. No significant differences in rooting due to K-IBA concentration or mist interval were observed.

TABLE 1

Rooting percentage for Rhododendron austrinum *and* R. canescens.

Treatment	*Rhododendron austrinum*	*Rhododendron canescens*
K-IBA CONCENTRATION[z]		
0 ppm	63	75
2500 ppm	63	75
5000 ppm	50	75
7500 ppm	38	100
10 000 ppm	100	88
MIST INTERVAL[y]		
4 s:6 min	75a	95a
4 s:12 min	60a	70a
SIGNIFICANCE[x]		
Split-plot		
Replication	NS	NS
Mist interval (M)	NS	NS
K-IBA concentration (H)	NS	NS
M*H	NS	NS
Concentration regression		
Linear	NS	NS
Quadratic	**	NS
r^2	0.1166	0.0346

[z] Means followed by * within columns are different from the control at the 5% level using Dunnett's two-tailed *t* test, n = 8. Comparisons were calculated using ARSIN transformation. Rooting percentages are presented as nontransformed means.

[y] Means followed by the same letter within columns are not different at the 5% level using Fisher's Protected Least Significant Difference, n = 20.

[x] NS, *, **, or *** represents non-significant or significant at the 10, 5, or 1% levels, respectively.

Cuttings treated with 10 000 ppm K-IBA had greater root numbers, average root length, and root quality when compared with cuttings treated with 0 ppm K-IBA (Table 3). Root numbers, average root length, and root quality for cuttings treated with 2500, 5000, or 7500 ppm K-IBA were similar to ratings for cuttings treated with 0 ppm K-IBA. Cutting growth was not influenced by K-IBA concentration. Root number, average root length, and root quality were not influenced by mist interval (Table 3). Cuttings placed in mist for 4 s:6 min grew more compared with cuttings placed in mist for 4 s:12 min.

DISCUSSION

Orange Azalea

Although statistical differences in rooting percentage were lacking, numbers were greatest for cuttings treated with 10,000 ppm K-IBA, which provided almost 40% more viable cuttings compared with the next numerically best K-IBA level, 0 or 2500 ppm. Therefore, the K-IBA concentration that yielded the most viable cuttings in this experiment is higher than the one recommended by Berry (1998). Higher concentrations of pow-

TABLE 2

Influence of mist interval and K-IBA concentration on root response and cutting growth for Rhododendron austrinum.

Treatment	Root number	Average root length ^{z} (cm)	Root quality ^{y}	Cutting growth (cm)
K-IBA CONCENTRATION ^{x}				
0 ppm	6.6	2.1	1.1	3.0
2500 ppm	17.1	3.4	1.4	4.4
5000 ppm	21.9	4.2	1.9	3.6
7500 ppm	33.9*	5.9*	3.3*	4.7
10 000 ppm	21.8	6.0*	3.3*	4.4
MIST INTERVAL ^{w}				
4 s:6 min	25.6a	4.9a	2.5a	4.6a
4 s:12 min	14.9b	3.8a	1.9a	3.5a
SIGNIFICANCE ^{v}				
Split-plot				
Replication	NS	NS	NS	NS
Mist interval (M)	***	NS	NS	NS
K-IBA concentration (H)	**	***	**	NS
MI*HC	NS	NS	NS	NS
Regression				
Linear	**u	NS	NS	NS
Quadratic	*	NS	NS	NS
r^2	0.2243	0.3256	0.2777	0.0528

^{z} Average root length = (sum of lengths of 3 longest roots/3).

^{y} Root quality rating = 0 to 4 with 0 being dead and 4 being a well-rooted cutting.

^{x} Means followed by * within columns are different from the control at the 5% level using Dunnett's two-tailed *t* test, n = 12.

^{w} Means followed by the same letter within columns are not different at the 5% level using Fisher's Protected Least Significant Difference, n = 30.

^{v} NS, *, **, or *** represents non-significant or significant at the 10, 5, or 1% levels, respectively.

^{u} Root number exhibited both a linear ($y = 0.0062(x) + 5.4268$) and a quadratic ($y = 0.0062(x) + -4.3286E-7(x^2) + 5.4268$) response to K-IBA concentration.

Conversion: 1 cm = 0.6 in

der hormone formulations, however, have been recommended by Bir (1992) and Sommerville (1998).

Both average root length and root quality ratings of cuttings treated with 10 000 or 7500 ppm K-IBA were better than ratings for cuttings treated with 0 ppm K-IBA. Treating cuttings with 10 000 ppm K-IBA resulted in an average of 3.9 cm of additional root growth compared with the control, and treating cuttings with 7500 ppm K-IBA resulted in an additional 3.8 cm of average root growth compared with the control. Although average root length and root quality of cuttings treated with 7500 ppm K-IBA were greater than those of the control, use of this K-IBA level resulted in a much smaller number of rooted cuttings, which can affect a producer=s profit level. Although Sommerville (1998) suggests cuttings start to grow more rapidly when no hormone is used, no differences in cutting growth due to K-IBA concentration were detected in this experiment. An adequate root system, however, is necessary to support shoot growth (Hartmann and others 2002). Therefore, it appears that cuttings treated with higher levels of K-IBA may be better able to support future

TABLE 3

Influence of mist interval and K-IBA concentration on root response and cutting growth for Rhododendron canescens.

Treatment	Root number	Average root length [z] (cm)	Root quality [y]	Cutting growth (cm)
K-IBA CONCENTRATION [x]				
0 ppm	6.3	2.5	0.6	3.9
2500 ppm	8.5	2.8	1.0	2.2
5000 ppm	8.0	2.9	0.9	2.3
7500 ppm	5.3	2.8	0.8	2.5
10 000 ppm	41.3*	7.0*	3.0*	5.6
MIST INTERVAL [w]				
4 s:6 min	14.3a	4.2a	1.4a	4.8a
4 s:12 min	13.5a	3.0a	1.1a	1.8b
SIGNIFICANCE [v]				
Split-plot				
Replication	NS	**	**	NS
Mist interval (M)	NS	NS	NS	*
K-IBA concentration (H)	***	***	***	NS
M*H	NS	NS	NS	NS
Regression				
Linear	**u	NS	NS	*r
Quadratic	***	*t	***s	**
r^2	0.5066	0.2326	0.3584	0.1146

[z] Average root length = (sum of lengths of 3 longest roots/3).

[y] Root quality rating = 0 to 4 with 0 being dead and 4 being a well-rooted cutting.

[x] Means followed by * within columns are different from the control at the 5% level using Dunnett's two-tailed *t* test, n = 12.

[w] Means followed by the same letter within columns are not different at the 5% level using Fisher's Protected Least Significant Difference, n = 30.

[v] NS, *, **, or *** represents non-significant or significant at the 10, 5, or 1% levels, respectively.

[u] Root number exhibited both a linear ($y = -0.0048(x) + 9.8214$) and quadratic ($y = -0.0048(x) + 7.4571E-7(x^2) + 9.8214$) response to K-IBA concentration.

[t] Average root length ($y = -0.0005(x) + 8.5238E-8(x^2) + 2.8613$) exhibited a quadratic response to K-IBA concentration.

[s] Root quality ($y = -0.0003(x) + 4.3000E-8(x^2) + 0.9000$) exhibited a quadratic response to K-IBA concentration.

[r] Cutting growth exhibited both a linear ($y = -0.001(x) + 3.9768$) and quadratic ($y = -0.001(x) + 1.1214E-7(x^2) + 3.9768$) response to K-IBA concentration.

Figure 1. Orange azalea cuttings treated with 5000 ppm K-IBA and placed under mist for 4 s:6 min (left) or 4 s:12 min (right).

Figure 2. Mountain azalea cuttings treated with 10 000 ppm K-IBA and placed under mist for 4 s:6 min (left) or 4 s:12 min (right).

shoot growth. Cuttings that were placed under mist that ran more frequently had more roots than plants that were kept drier (Figure 1). These data are supported by the frequent misting reported by Sommerville (1998).

Regression analysis indicated that rooting percentage followed a quadratic trend. Root numbers exhibited both a linear and a quadratic response to K-IBA concentration although the linear response was stronger. These results indicate that increases in K-IBA concentration beyond those used in this experiment could reduce rooting percentage although root numbers might be increased by slight increases in hormone concentration.

Analyses indicate much variability in these results. This variability can be attributed to the difficulty associated with rooting cuttings when there is a lack of information concerning cultural requirements. Several other factors may also have an influence. Cuttings were taken from an established grouping of older plants, and juvenility is a trait often linked to propagation success (Hartmann and others 2002). Optimum fertility is often mentioned as a requirement for propagation success, but the cuttings came from plants in natural settings where fertilizer is not applied (Sommerville 1998). Finally, cuttings were taken from several plants within the grouping, and this may have resulted in propagation differences attributable to slight genetic differences among plants. Although more cuttings would have reduced error, only limited material was available in the grouping.

Mountain Azalea

Rooting percentage was highest for cuttings treated with 7500 ppm K-IBA, which results in about 12% more rooted cuttings than the next best K-IBA level of 10 000 ppm. Both of these K-IBA levels are higher than the K-IBA levels recommended by Berry (1998) but similar to concentrations reported by Knight and others (2001). As for orange azalea, higher concentrations of powder hormone formulations have also been recommended by Bir (1992) and Sommerville (1998).

Root numbers, average root length, and root quality were higher for cuttings treated with 10 000 ppm K-IBA compared with cuttings treated with 0 ppm K-IBA. Treating cuttings with 10 000 ppm K-IBA resulted in 35 more roots, 5 cm of additional root growth, and a 2.4 increase in root quality rating compared with measurements of cuttings treated with 0 ppm K-IBA. Similar to orange azalea, growth did not respond to K-IBA concentration. These results contradict Sommerville (1998) who suggested that cuttings treated without hormone should exhibit shoot growth within 1.5 to 2 months. Additionally, the increase in measured parameters exhibited by cuttings treated with 10000 ppm compared to cuttings treated with 0 ppm K-IBA is consistent with results for orange azalea. Cuttings with better root systems should be able to more adequately support shoot growth (Hartmann and others 2002). Cuttings that were placed in mist that ran more frequently grew more than cuttings that were drier (Figure 2), results consistent with Sommerville (1998).

Regression analyses indicated that root number and cutting growth exhibited both a linear and quadratic response to K-IBA concentration, and the quadratic response was stronger for both variables. Average root length and root quality only displayed a quadratic response to K-IBA concentration. These results indicate that further increases in K-IBA concentration might reduce measured parameters. Variability in data can be attributed to the same factors as mentioned for orange azalea.

CONCLUSIONS

Both species grown in this experiment are moderate to difficult to root. That difficulty results in inherent variability in results. A better understanding of the cultural practices required for these species will ultimately result in a more uniform product. Cuttings of both species rooted when treated with low levels of K-IBA, however, the use of 10 000 ppm K-IBA appears to increase root number, length, and quality, which could result in a more marketable product. Therefore, for mountain azalea, propagators must decide whether to sacrifice a slight increase in rooting percentage (cuttings treated with 7500 ppm K-IBA) for increases in overall rooting performance (cuttings treated with 10 000 ppm K-IBA); 12% more cuttings but lacking an adequate root system probably provides no long-term advantage to producers. Additionally, mountain azalea seems to have a slight preference for more frequent misting. Although cuttings of both species rooted fairly easily as reported by Galle (1987), poor overall cutting quality suggests that initiating new growth is as difficult as reported by Dirr and Heuser (1987). Discovery of optimal light, fertilizer, and other cultural practices might reduce the K-IBA concentration needed for optimum rooting response.

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